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RELATIONSHIP BETWEEN DURATION OF TYPE 2 DIABETES MELLITUS AND TYPE OF DIABETIC RETINOPATHY IN OUTPATIENTS WITH DIABETES MELLITUS

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Abstract

Type 2 diabetes mellitus (T2DM) is the most common type of diabetes. Chronic hyperglycemia in T2DM can damage blood vessels, causing both macroangiopathy and microangiopathy. Microvascular complications tend to develop more rapidly and are more common than macrovascular complications, and diabetic retinopathy (DR) is one of the most frequent microvascular complications. The duration of diabetes mellitus (DM) is considered a risk factor for DR because it determines how long the retina is exposed to hyperglycemia, oxidative stress, and endothelial damage. This study aimed to determine the relationship between the duration of T2DM and the type of diabetic retinopathy in patients at Sultan Agung Islamic Hospital, Semarang. This was an analytic observational study with a cross-sectional design. The sample consisted of 54 T2DM patients with DR, selected by consecutive sampling and divided into three groups by DM duration: <5 years, 5–10 years, and >10 years. DR type was classified as non-proliferative diabetic retinopathy (NPDR) or proliferative diabetic retinopathy (PDR). Data were analyzed using the Chi-Square test. The results showed that most subjects had PDR (68.5%), while 31.5% had NPDR. The Chi-Square test showed no significant relationship between T2DM duration and DR type ($p = 0.709$; Cramer's $V = 0.113$). Analysis of other factors showed that hypertension was significantly associated with DR type ($p < 0.001$; Phi = 0.523). The proportion of PDR was 87.9% in hypertensive patients, compared with 38.1% in patients without hypertension. Sex, age, smoking, and body mass index were not associated with DR type ($p > 0.05$). In conclusion, there was no significant relationship between the duration of T2DM and diabetic retinopathy in patients at Sultan Agung Islamic Hospital, Semarang, whereas hypertension was significantly associated with the type of diabetic retinopathy.

Keyword: *Type 2 Diabetes Mellitus, Duration, Hypertension, Diabetic Retinopathy*

A. INTRODUCTION

Type 2 diabetes mellitus (T2DM) is the most common type of diabetes in the community. Chronic hyperglycemia in T2DM can damage blood vessels, both large vessels (macroangiopathy) and small vessels (microangiopathy). Macroangiopathy manifests as heart disease, stroke, and peripheral arterial disease. Microangiopathy manifests as diabetic nephropathy, diabetic neuropathy, and diabetic retinopathy. The organs most vulnerable to

damage include the eyes, kidneys, peripheral nerves, heart, and peripheral blood vessels (Soelistijo, 2024; Kementerian Kesehatan Republik Indonesia, 2026a). Microvascular complications tend to develop more rapidly and are more common than macrovascular complications. Diabetic retinopathy is one of the most frequent microvascular complications (Seid *et al.*, 2021). In the early phase of the disease, patients often do not experience typical symptoms, so diagnosis tends to be delayed (Soelistijo, 2024; Magliano *et al.*, 2025).

T2DM is the most common form of diabetes, so the global rise in diabetes prevalence mainly reflects an increasing burden of T2DM (Soelistijo, 2024; Magliano *et al.*, 2025). The International Diabetes Federation estimated that 588.7 million adults aged 20–79 years were living with diabetes in 2024, and this number is projected to reach 852.5 million by 2050. Indonesia is among the countries with the highest number of people with diabetes in the world, with an estimated 20.4 million cases in 2024 and a projection of 28.6 million by 2050 (Magliano *et al.*, 2025; Kementerian Kesehatan Republik Indonesia, 2026a). An analysis of Indonesian national health surveys for 2013–2023 showed that the prevalence of diabetes among adults has remained high over the past decade (Muharram *et al.*, 2025). The large number of T2DM patients increases the need to monitor chronic complications. Microvascular complications develop more rapidly and are more common than macrovascular complications, and diabetic retinopathy is one of the most frequent (Seid *et al.*, 2021). Globally, about one-third of people with diabetes develop diabetic retinopathy. In Indonesia, its prevalence reaches 43.1%, with sight-threatening diabetic retinopathy at 26.1% (Kementerian Kesehatan Republik Indonesia, 2023).

Complications in T2DM patients in Indonesia contribute substantially to morbidity, disability, and mortality, through chronic macrovascular complications (heart disease, stroke, peripheral arterial disease) and microvascular complications (nephropathy, retinopathy, neuropathy). These complications are also a major driver of the cost burden of the national health insurance program (JKN-BPJS Kesehatan) (Firman, 2024; Soelistijo, 2024). T2DM patients with complications have much higher treatment costs than those without complications, and nephropathy and cardiovascular complications generate the largest total costs (Aisyari, 2023). If complications are not detected and managed appropriately, they continue to progress. Diabetic retinopathy, for example, can develop without symptoms until an advanced stage and then cause severe visual impairment and permanent blindness, especially in the productive age group (Kementerian Kesehatan Republik Indonesia, 2023; Purnama *et al.*, 2023). This condition reduces patients' productivity and independence, limits

daily activities, and adds an economic burden for patients, families, and the health insurance system.

Diabetic retinopathy is divided into two groups: non-proliferative and proliferative. Non-proliferative diabetic retinopathy (NPDR) covers the early to advanced stages before neovascularization occurs. Proliferative diabetic retinopathy (PDR) is a more severe stage, characterized by the formation of fragile new blood vessels that bleed easily. Knowing the type of diabetic retinopathy is important because it is related to the risk of visual impairment and the need for further management (Kementerian Kesehatan Republik Indonesia, 2023; Dalillah *et al.*, 2024).

Pathophysiologically, the longer a person has diabetes, the longer the retina is exposed to hyperglycemia. This exposure increases oxidative stress, damages capillary endothelium, causes pericyte loss, thickens the basement membrane, and increases vascular permeability. As a result, the retina is damaged progressively, from microaneurysms to neovascularization (Purnama *et al.*, 2023; Deviyana *et al.*, 2024; Pei and Li, 2025). Shaniaputri *et al.* (2022) and Deviyana *et al.* (2024) found a higher prevalence of diabetic retinopathy with longer DM duration. Tolani *et al.* (2026) and Primaputri *et al.* (2022) reported a significant relationship between DM duration and the type of diabetic retinopathy ($p = 0.016$). However, Sahela *et al.* (2025) in Mojokerto found no significant relationship ($p = 0.921$). This difference is thought to arise from differences in the criteria used to group duration, and from patients who were newly diagnosed with DM only after eye abnormalities were found, so the recorded duration did not reflect the true length of illness (Puri *et al.*, 2024). Diabetic retinopathy is also multifactorial. Other contributing factors include glycemic control (HbA1c), body mass index, hypertension, dyslipidemia, age, and smoking (Andriawan *et al.*, 2025; Urrahmi *et al.*, 2025; Wilwatikta *et al.*, 2025). Thus, findings on the relationship between DM duration and the type of diabetic retinopathy are not yet consistent. In addition, to the researchers' knowledge, data on the patient population in Semarang remain limited.

Based on the above, the researchers aimed to determine the relationship between the duration of type 2 diabetes mellitus and the type of diabetic retinopathy in patients at Sultan Agung Islamic Hospital, Semarang. This hospital is a referral and teaching hospital in Semarang that serves T2DM patients with diverse clinical characteristics. The results are expected to describe the pattern of retinopathy type according to the length of diabetes and to serve as a consideration for improving early detection of eye complications in T2DM patients.

B. RESEARCH METHOD

3.1 Study Design and Variables

This was an analytic observational study with a cross-sectional design. The exposure and the outcome were assessed at a single point in time, without any intervention by the researcher. The study was conducted at Sultan Agung Islamic Hospital, Semarang, using data from the Ophthalmology Outpatient Clinic and the Medical Records Unit. Data were collected in September–October 2026. The independent variable was the duration of type 2 diabetes mellitus (T2DM), categorized as <5 years, 5–10 years, and >10 years. The dependent variable was the type of diabetic retinopathy (DR), classified as non-proliferative DR (NPDR) or proliferative DR (PDR). Age, sex, hypertension, smoking status, and body mass index (BMI) were examined as additional factors.

3.2 Population and Sample

The study population comprised all patients with T2DM who were diagnosed with DR at Sultan Agung Islamic Hospital. The sample consisted of patients from this population who met the inclusion and exclusion criteria. Patients were eligible if they had a confirmed diagnosis of T2DM, had a DR diagnosis made by an ophthalmologist and recorded in the medical record, had complete medical records, and could be contacted by telephone and agreed to be interviewed. Patients were excluded if they had incomplete medical records, had other retinal diseases that could affect classification, had a history of retinal surgery or laser therapy that obscured the DR type, or could not be reached after repeated attempts.

The sample size was calculated with state the formula, expected effect size, power, and confidence level, which gave a minimum of 54 subjects. Because the independent variable had three categories, the sample was divided equally into three duration strata, with 18 subjects in each stratum.

Participants were recruited by consecutive sampling with stratification by duration. The researcher screened the medical records of patients with T2DM and DR who attended the hospital during the study period. Each patient who met the criteria was assigned to a stratum according to the duration of diabetes recorded in the medical record or reported at interview. Patients were enrolled in the order they were encountered. When a stratum reached 18 subjects, further patients for that stratum were no longer enrolled. Recruitment continued until all three strata were filled and the total reached 54 patients.

3.3 Data Collection Procedure and Operational Definitions

Data collection used two sources: medical records and telephone interviews. First, the

researcher obtained permission from the hospital and ethics approval. Then the researcher identified eligible patients from the medical records. The following data were taken from the records: age, sex, DR type, blood pressure or hypertension diagnosis, and body weight and height for the BMI calculation. Telephone numbers were taken from the registration data in the medical records.

Because duration of diabetes and smoking history were not always complete in the records, these two variables were confirmed by telephone interview. The researcher called each eligible patient, using the contact number in the medical record. At the start of the call, the researcher introduced themselves, explained the purpose and procedure of the study, and stated that participation was voluntary and that the patient's data would be kept confidential. Verbal informed consent was obtained before the interview began and recorded. If the patient could not answer, a family member who knew the patient's history could answer on the patient's behalf. The researcher then asked two questions: (1) in which year, or how many years ago, the patient was first diagnosed with diabetes mellitus, and (2) whether the patient was currently or had ever been a smoker. The answers were compared with the medical record. Patients who could not be reached or declined to take part were replaced by the next eligible patient in the same stratum.

The variables were defined as follows. T2DM duration was the time from the first diagnosis to the time of data collection, grouped as <5 years, 5–10 years, and >10 years. DR type was taken from the ophthalmologic diagnosis in the medical record and classified as NPDR or PDR. Hypertension was defined as blood pressure >140/90 mmHg. BMI was calculated as body weight in kilograms divided by height in meters squared, and categorized as normal, overweight, or obese according to the WHO Asia-Pacific criteria. Age was grouped as <60 years and ≥60 years. Smoking was recorded as yes or no.

3.4 Data Analysis

Data were processed and analyzed with SPSS. Univariate analysis described the characteristics of the subjects. Categorical variables were presented as frequencies and percentages, and age and T2DM duration were also presented as mean values. Bivariate analysis was then used to test the relationship between each factor and DR type. The Chi-Square test was used for duration, sex, and hypertension. Fisher's Exact test was used for age, smoking, and BMI, because their expected cell counts did not meet the Chi-Square assumptions. The strength of association was reported as Cramer's V for the duration variable, which has three categories, and as the Phi coefficient for 2×2 tables. A p-value below 0.05 was considered

statistically significant.

C. RESULT AND DISCUSSION

This study was conducted at Sultan Agung Islamic Hospital, Semarang, using an analytic observational design with a cross-sectional approach. Data on diabetic retinopathy (DR) type, age, sex, and history of hypertension were obtained from the medical records of patients who met the inclusion and exclusion criteria in October 2026. Data on the duration of type 2 diabetes mellitus (T2DM) and smoking history were obtained through direct interviews with the research respondents. Samples were selected by consecutive sampling with stratification by T2DM duration. A total of 54 samples were analyzed, consisting of 18 patients in each duration category (<5 years, 5–10 years, and >10 years). All data were complete with no missing values, so every subject was included in the analysis.

Characteristic	Category	n	%
Age group	<60 years (non-elderly)	41	75.9
	≥60 years (elderly)	13	24.1
Sex	Male	21	38.9
	Female	33	61.1
T2DM duration category	<5 years	18	33.3
	5–10 years	18	33.3
	>10 years	18	33.3
Hypertension	No	21	38.9
	Yes	33	61.1
Smoking	No	48	88.9

Characteristic	Category	n	%
	Yes	6	11.1
BMI	Normal	35	64.8
	Overweight	15	27.8
	Obese	4	7.4
Diabetic retinopathy type	NPDR	17	31.5
	PDR	37	68.5

The distribution of DR types showed that 37 subjects (68.5%) had proliferative diabetic retinopathy (PDR) and 17 subjects (31.5%) had non-proliferative diabetic retinopathy (NPDR). The duration of T2DM ranged from 1 to 30 years, with a median of 6 years. The mean duration of T2DM was 8.63 ± 6.93 years. The median duration was 7 years (range 1–30) in the NPDR group and 6 years (range 2–30) in the PDR group.

The mean age of the subjects was 53.91 ± 8.38 years, with a range of 35–70 years. Most subjects were female (33 patients; 61.1%). Hypertension was recorded in 33 patients (61.1%), and 6 patients (11.1%) were smokers. Based on body mass index (BMI), 35 patients (64.8%) had normal BMI, 15 patients (27.8%) were overweight, and 4 patients (7.4%) were obese.

The data on T2DM duration were categorized into three groups (<5 years, 5–10 years, and >10 years), with 18 patients in each group, while the type of diabetic retinopathy was categorized as NPDR and PDR. Both variables were categorical, so they were analyzed with the Chi-Square test. This test was appropriate because no cell had an expected count of less than 5 (the minimum expected count was 5.67).

T2DM duration category	NPDR		PDR		Total	*p-value*
	n	%	n	%		
<5 years	5	27,8	13	72,2	18	
5–10 years	7	38,9	11	61,1	18	0,709

T2DM duration category	NPDR		PDR		Total	*p-value*
	n	%	n	%		
>10 years	5	27,8	13	72,2	18	
Total	17	31,5	37	68,5	54	

The proportion of PDR in the <5 years duration group was 72.2% (13 of 18 patients). In the 5–10 years group, the proportion was 61.1% (11 of 18), and in the >10 years group it was 72.2% (13 of 18). There was no pattern of increasing PDR with longer duration of diabetes mellitus. The Chi-Square test showed a p-value of 0.709 (>0.05), so there was no significant relationship between T2DM duration and diabetic retinopathy type, and the strength of association was very weak (Cramer's V = 0.113).

The relationship between other risk factors and diabetic retinopathy type is presented in Table 4.3. Sex and hypertension were tested with the Chi-Square test because all cells had an expected count of ≥5. Age, smoking, and BMI were tested with Fisher's Exact test (the Fisher-Freeman-Halton test for BMI) because more than 20% of their cells had an expected count of <5.

Table 4.3. Relationship between Other Risk Factors and Diabetic Retinopathy Type

Variable	Category	NPDR		PDR		*p-value*	Test
		n	%	n	%		
Sex	Male	7	33,3	14	66,7	0,815	*Chi-square*
	Female	10	30,3	23	69,7		
Age	<60 years	11	26,8	30	73,2	0,303	*fisher*
	≥60 years	6	46,2	7	53,8		
Hypertension	No	13	61,9	8	38,1	**0,0001**	*Chi-square*
	Yes	4	12,1	29	87,9		
Smoking	No	16	33,3	32	66,7	0,652	*fisher*
	Yes	1	16,7	5	83,3		
BMI	Normal	12	34,3	23	65,7	0,466	*fisher*
	Overweight	3	20,0	12	80,0		
	Obese	2	50,0	2	50,0		

Based on the results of the analysis of the relationship between diabetic retinopathy type and other factors, sex (p-value = 0.815), age (p-value = 0.303), smoking (p-value = 0.652), and BMI (p-value = 0.466) were not significantly associated with diabetic retinopathy type, as all p-values were >0.05. In contrast, hypertension was significantly associated with diabetic retinopathy type (p-value <0.001). Among patients with hypertension, 87.9% (29 of 33 patients) had PDR. This proportion was much higher than in patients without hypertension, of whom only 38.1% (8 of 21 patients) had PDR. The Phi coefficient of 0.523 indicates a moderate strength of association between the two variables.

DISCUSSION

This study included 54 patients with type 2 diabetes mellitus (T2DM) at Sultan Agung Islamic Hospital, Semarang. The mean age was 53.91 ± 8.38 years, and 75.9% of respondents were younger than 60 years. This is older than the sample of Al Ashoor *et al.* (2023) in Basrah (mean 35.9 years) but younger than that of Suzuki and Kiyosawa (2023) (70.1 ± 10.1 years). Women made up 61.1% of respondents, similar to Al Ashoor *et al.* (2023) (55.3%) and Tolani *et al.* (2026) (68.36%). Hypertension was present in 61.1% of respondents and smoking in 11.1%. Most respondents had a normal body mass index (BMI) (64.8%), followed by overweight (27.8%) and obesity (7.4%). The mean duration of diabetes was 8.63 ± 6.93 years (median 6 years). Each duration category (<5 years, 5–10 years, >10 years) contained 18 respondents (33.3%) because of stratified sampling, so this distribution does not reflect the natural distribution of patients. It also differs from Tolani *et al.* (2026), in which only one of 177 patients (0.56%) had a duration of >10 years.

Most respondents had proliferative diabetic retinopathy (PDR) (68.5%), and 31.5% had non-proliferative diabetic retinopathy (NPDR). This is probably related to the hospital's role as a class B referral hospital. In Indonesia's tiered referral system, patients are usually treated first at primary care facilities and are referred to a class B hospital only when advanced care is needed. Patients who reach this level are therefore more likely to have advanced disease. Because the sample included only patients with diabetic retinopathy and was stratified by duration, this proportion is not the prevalence of PDR among all patients with diabetes and cannot be generalized.

Diabetes duration was not significantly associated with diabetic retinopathy type (Chi-Square, p = 0.709; Cramer's V = 0.113, a very weak association). The proportions of PDR in the <5-year, 5–10-year, and >10-year groups were 72.2%, 61.1%, and 72.2%, respectively, with no

increasing trend. This agrees with Sahela *et al.* (2025) in Mojokerto, who also found no significant association (p = 0.921).

Several explanations are possible. First, retinal damage can begin before diabetes is diagnosed. Andersson *et al.* (2024) reported that 12% of patients already had retinopathy at diagnosis, rising to 32% after three years. Because T2DM is often asymptomatic in its early phase, the recorded duration may be shorter than the true duration. In this study, duration was obtained by interview and depended on patient recall, which may have introduced misclassification. This may partly explain why 72.2% of patients with a duration of <5 years already had PDR. Second, glycemic control also contributes to retinopathy (Bulum, 2022; Suzuki and Kiyosawa, 2023; Andersson *et al.*, 2024). A patient with a short duration and poor control may develop more severe damage than a patient with a long duration and good control. HbA1c data were not available, so these results do not mean that duration plays no role.

Different results were reported by Tolani *et al.* (2026), who found a significant association (p < 0.001) among 177 patients, with PDR rising from 23.9% in the <5-year group to 55.0% in the 5–10-year group (OR 4.01; 95% CI 2.05–7.82). However, the >10-year group contained only one patient. Al Ashoor *et al.* (2023) and Suzuki and Kiyosawa (2023) also reported associations with duration, but they assessed the presence of retinopathy rather than its type among patients already affected.

Hypertension was the only factor significantly associated with retinopathy type (p < 0.001). PDR occurred in 87.9% of patients with hypertension and in 38.1% of those without it. The Phi coefficient was 0.523, indicating a moderate association. This is consistent with Andersson *et al.* (2024), who linked high blood pressure at diagnosis to later retinopathy, with Al Ashoor *et al.* (2023) (p = 0.004), and with Trott *et al.* (2022), who reported that tighter blood pressure targets reduced retinopathy risk by about 20%.

The association is biologically plausible. Chronic hyperglycemia damages retinal capillaries through pericyte loss, basement membrane thickening, and endothelial dysfunction. In diabetes, retinal autoregulation is impaired, so high systemic pressure is transmitted directly to fragile capillaries. This increases leakage and capillary occlusion, causes retinal ischemia, and raises vascular endothelial growth factor (VEGF), which promotes the new vessel formation characteristic of PDR. Activation of the local renin–angiotensin system by hyperglycemia and hypertension further amplifies this process.

Because of the cross-sectional design, only an association can be shown. Hypertension may be a risk factor, may share a common cause with retinopathy (insulin resistance and

metabolic syndrome), or may result from severe microvascular disease through diabetic nephropathy. Data on renal function, HbA1c, lipid profile, and the duration and control of hypertension were not available, so these possibilities could not be separated. Bulum (2022) found no association between blood pressure and retinopathy in T2DM, possibly because of a small sample (107 patients) and a different outcome (presence of retinopathy, not NPDR versus PDR). The high proportion of hypertension may also reflect selection bias in a referral hospital. Even so, the consistent direction of the association, its moderate strength, and its biological basis support controlling blood pressure together with blood glucose in patients with T2DM.

Sex ($p = 0.815$), age ($p = 0.303$), smoking ($p = 0.652$), and BMI ($p = 0.466$) were not significantly associated with retinopathy type. These findings should be interpreted in light of the sample composition and do not prove that these factors are unimportant.

The literature on sex is inconsistent: Al Ashoor *et al.* (2023) found higher retinopathy in women ($p = 0.005$), whereas Zaman *et al.* (2025) reported an opposite direction (OR = 0.6). For age, the narrow range in this study (most respondents <60 years) may explain the absence of an association, while Al Ashoor *et al.* (2023) included participants aged 20–82 years and found a significant association ($p < 0.001$). Smoking (11.1%) and obesity (7.4%) were uncommon in this sample, so group comparisons were unbalanced and small differences were unlikely to be detected. Al Ashoor *et al.* (2023) found an association with smoking ($p < 0.001$) among 1,542 respondents, and Trott *et al.* (2022) reported that obesity increased retinopathy risk (RR = 1.34) in pooled data from much larger samples.

Eye examination should begin when T2DM is diagnosed rather than after a longer duration, since retinopathy can already be present at diagnosis (Andersson *et al.*, 2024). Blood pressure should be controlled alongside blood glucose, and medication adherence, which remains a challenge for chronic disease in Indonesia, should be monitored at each visit. Periodic screening should also continue in patients with a longer disease duration (Tolani *et al.*, 2026).

This study has several limitations. First, duration was obtained by interview and is subject to recall bias. Second, the sample came from a single referral hospital and was stratified by duration, so it does not represent the natural population and cannot be generalized. Third, HbA1c, lipid profile, renal function, and medication adherence were not available and could not be controlled as confounders. Fourth, the small sample ($n = 54$), with few smokers and obese patients, limited statistical power. Finally, the cross-sectional design cannot establish causality.

D. CONCLUSION

The duration of type 2 diabetes mellitus (T2DM) was evenly distributed across three categories (<5 years, 5–10 years, and >10 years), with 18 respondents (33.3%) in each category because of stratified sampling, and the mean duration was 8.63 ± 6.93 years (median 6 years). Proliferative diabetic retinopathy (PDR) was the most common type, found in 37 respondents (68.5%), while non-proliferative diabetic retinopathy (NPDR) was found in 17 respondents (31.5%). There was no significant association between T2DM duration and diabetic retinopathy type ($p = 0.709$; Cramer's $V = 0.113$), and the proportions of PDR in the <5-year, 5–10-year, and >10-year groups were 72.2%, 61.1%, and 72.2%, respectively. Among the other factors examined, only hypertension was significantly associated with diabetic retinopathy type ($p < 0.001$), with PDR found in 87.9% of patients with hypertension compared with 38.1% of those without hypertension. Sex, age, smoking, and body mass index were not significantly associated with diabetic retinopathy type.

SUGGESTION

Future studies should use a larger sample, involve more than one hospital, and apply a cohort design to determine the relationship between type 2 diabetes mellitus (T2DM) duration and diabetic retinopathy type more accurately. Such studies should also include HbA1c, lipid profile, and renal function as confounding variables. In clinical practice, eye examination (diabetic retinopathy screening) should be performed as soon as T2DM is diagnosed, without waiting for the disease duration to increase, because proliferative diabetic retinopathy (PDR) was already found in patients with a duration of <5 years. Blood pressure should be measured and monitored at every visit of patients with T2DM and controlled together with blood glucose. Patients with hypertension need closer attention in eye screening, for example through more regular examinations and earlier referral to an ophthalmologist. Finally, patients with T2DM, especially those with hypertension, should be educated to take antidiabetic and antihypertensive medications regularly, attend routine follow-up visits, and undergo periodic eye examinations even in the absence of visual complaints.

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